CLAIMS

Having described the invention, what is claimed is:

1. An apparatus for treating wastewater comprising:

(a) a wastewater inlet conduit;

(b) a solids separation tank to receive said wastewater from said inlet conduit, for the separation of solids from liquid in said wastewater;

(c) an oxidation tank in fluid communication with said solids separation tank to receive liquid from said solids separation tank;

(d) a liquid outlet conduit from said oxidation tank to conduct liquid from said oxidation tank;

(e) a source of gas comprising ozone;

(f) means for dissolving said gas comprising ozone in liquid from said liquid outlet conduit;

(g) a re-circulating circuit for conducting said liquid with dissolved gas comprising ozone to said solids separation tank and said oxidation tank;

(h) discharge means for discharging said liquid with dissolved gas comprising ozone into said solids separation tank and oxidation tank, whereby said dissolved gas comprising ozone forms gas bubbles in said solids separation tank and oxidation tank; and

(i) a liquid discharge conduit to discharge treated liquid from said apparatus.

2. An apparatus according to claim 1, wherein said oxidation tank comprises a plurality of chambers in fluid communication with each other, including an inlet chamber operatively connected to said solids separation tank and an outlet chamber from which liquid exits into said liquid outlet conduit, whereby liquid can flow from said inlet chamber through any intermediate chambers and into said outlet chamber.

3. An apparatus according to claim 2 wherein each chamber of said plurality of chambers has said discharge means.

4. An apparatus according to claim 3 wherein there are three said chambers.

5. An apparatus according to claim 1 wherein said discharge means is a nozzle comprising a plate with an orifice and a baffle plate spaced from said orifice.

6. An apparatus according to claim 1, wherein said source of gas comprising ozone comprises an ozone generator and an oxygen concentrator to supply oxygen to said ozone generator.

7. An apparatus according to claim 1 wherein said means for dissolving said gas comprises a pump.

8. An apparatus according to claim 1, further comprising means to remove any excess ozone from said oxidation tank.

9. An apparatus according to claim 1 further comprising a source of ultraviolet radiation to irradiate at least a portion of said liquid with dissolved gas comprising ozone in said re-circulating circuit to produce hydroxyl radicals.

10. An apparatus according to claim 1 further comprising a grinder to grind solids in said sewage prior to introduction of said sewage into said solids separation tank.

11. An apparatus for treating sewage comprising:

(a) a wastewater inlet conduit;

(b) a solids separation tank to receive said wastewater from said inlet conduit, with gas distribution means therein for the separation of solids from liquid in said wastewater by gas flotation;

(c) an oxidation tank in fluid communication with said solids separation tank to receive liquid from said solids separation tank;

(d) a liquid outlet conduit from said oxidation tank to conduct liquid from said oxidation tank;

(e) a source of gas comprising ozone;

(f) means for dissolving said gas comprising ozone in liquid from said liquid outlet conduit;

(g) a re-circulating circuit for conducting said liquid with dissolved gas comprising ozone to said oxidation tank;

(h) discharge means for discharging said liquid with dissolved gas comprising ozone into said oxidation tank, whereby said dissolved gas comprising ozone forms gas bubbles in said oxidation tank; and,

(i) a liquid discharge conduit to discharge treated liquid from said apparatus.

12. An apparatus according to claim 11, wherein said oxidation tank comprises a plurality of chambers in fluid communication with each other, including an inlet chamber operatively connected to said solids separation tank and an outlet chamber from which liquid exits into said liquid outlet conduit, whereby liquid can flow from said inlet chamber through any intermediate chambers and into said outlet chamber.

13. An apparatus according to claim 12 wherein each chamber of said plurality of chambers has said discharge means.

14. An apparatus according to claim 13 wherein there are three said chambers.

15. An apparatus according to claim 11 wherein said discharge means is a nozzle comprising a plate with an orifice and a baffle plate spaced from said orifice.

16. An apparatus according to claim 11, wherein said source of gas comprising ozone comprises an ozone generator and an oxygen concentrator to supply oxygen to said ozone generator.

17. An apparatus according to claim 11 wherein said means for dissolving said gas comprises a pump.

18. An apparatus according to claim 11, further comprising means to remove any excess ozone from said oxidation tank.

19. An apparatus according to claim 11 further comprising a source of ultraviolet radiation to irradiate at least a portion of said liquid with dissolved gas comprising ozone in said re-circulating circuit to produce hydroxyl radicals.

20. An apparatus according to claim 11 further comprising a grinder to grind solids in said sewage prior to introduction of said sewage into said solids separation tank.

21. A method for treating wastewater comprising the steps of:

(a) providing a treatment system comprising a solids separation tank, an oxidation tank and a liquid flow circuit whereby liquid flows from said solids separation tank into said oxidation tank, out of said oxidation tank and is reintroduced into said solids separation tank and said oxidation tank;

(b) dissolving a gas comprising ozone into said liquid in said liquid flow circuit after said liquid exits from said oxidation tank;

(c) introducing wastewater to be treated into said solids separation tank;

(d) separating solids from liquid in said wastewater in said solids separation tank;

(e) allowing said liquid from said solids separation tank to pass into said oxidation tank;

(f) introducing said liquid with dissolved gas comprising ozone into said liquid in said oxidation tank and allowing said gas comprising ozone to form bubbles in said liquid in said oxidation tank and cause oxidation of substances in said liquid in said oxidation tank; and

(g) removing treated liquid from said treatment system for discharge to the environment.

22. A method according to claim 21 wherein said step of separating solids from liquid comprises introducing said liquid with dissolved gas comprising ozone into said solids separation tank and allowing said dissolved gas comprising ozone introduced into said solids separation tank to form bubbles in said wastewater, thereby effecting separation of said solids in said wastewater by flotation and causing oxidation of substances in said wastewater.

23. A method according to claim 21 wherein said oxidation tank comprises a plurality of chambers including an inlet chamber operatively connected to said solids separation tank and an outlet chamber from which liquid exits from said oxidation tank, and said method includes the steps of introducing said dissolved gas comprising ozone into each of said chambers and allowing said liquid to flow from said inlet chamber, through any intermediate chambers and into said outlet chamber.

24. A method according to claim 21 wherein step (f) comprises directing said liquid with dissolved gas comprising ozone through

an orifice in a plate and against a baffle plate spaced from said orifice.

25. A method according to claim 21 further comprising the step of removing any excess ozone from said treatment system.

26. A method according to claim 21 further comprising the step of producing said gas comprising ozone.

27. A method according to claim 21 further comprising the step of periodically removing said separated solids from said solids separation tank.

28. A method according to claim 21 further comprising the step of irradiating at least part of said liquid with said dissolved gas comprising ozone with ultraviolet light to produce hydroxyl radicals.

29. A method for treating wastewater comprising the steps of:

(a) providing a treatment system comprising a solids separation tank, an oxidation tank and a liquid flow circuit whereby liquid flows from said solids separation tank into said oxidation tank, out of said oxidation tank and is reintroduced into said oxidation tank;

(b) dissolving a gas comprising ozone into said liquid in said liquid flow circuit after said liquid exits from said oxidation tank;

(c) introducing wastewater to be treated into said solids separation tank;

(d) separating solids from liquid in said wastewater in said solids separation tank by means of gas flotation;

(e) allowing said liquid from said solids separation tank to pass into said oxidation tank;

(f) introducing said liquid, with dissolved gas comprising ozone into said liquid in said oxidation tank and allowing said gas comprising ozone to form bubbles in said liquid in said oxidation tank and cause oxidation of substances in said liquid in said oxidation tank; and

(g) removing treated liquid from said treatment system for discharge to the environment.

30. A method according to claim 29 wherein said oxidation tank comprises a plurality of chambers including an inlet chamber operatively connected to said solids separation tank and an outlet chamber from which liquid exits from said oxidation tank, and said method includes the steps of introducing said dissolved gas

comprising ozone into each of said chambers and allowing said liquid to flow from said inlet chamber, through any intermediate chambers and into said outlet chamber.

31. A method according to claim 29 wherein step (f) comprises directing said liquid with dissolved gas comprising ozone through an orifice in a plate and against a baffle plate spaced from said orifice.

32. A method according to claim 29 further comprising the step of removing any excess ozone from said treatment system.

33. A method according to claim 29 further comprising the step of producing said gas comprising ozone.

34. A method according to claim 29 further comprising the step of periodically removing said separated solids from said solids separation tank.

35. A method according to claim 29 further comprising the step of irradiating at least part of said liquid with said dissolved gas comprising ozone with ultraviolet light to produce hydroxyl radicals.